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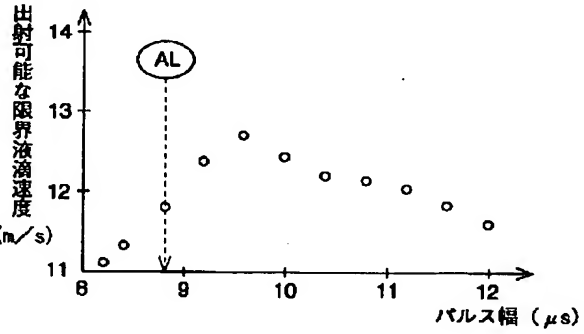
(54)【発明の名称】　インク滴噴射装置

(57)【要約】
【課題】　電気・機械変換手段を駆動する駆動パルスのパルス幅や印加周期を圧力発生室の音響的共振周期の二分の一であるＡＬの整数倍に設定する従来のインク滴噴射装置の駆動方法では、高周波駆動において、安定に欠ける等の問題があった。
【解決手段】　駆動パルスのパルス幅及び印加周期の少なくとも一つがＡＬの整数倍に実質的に等しくないように、駆動パルスを設定する。



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【特許請求の範囲】

【請求項１】　電気・機械変換手段、該電気・機械変換手段の作動により圧力を発生する圧力発生室、該圧力発生室の一端に形成され、圧力の作用によりインク滴を出射するノズル、前記圧力発生室にインクを供給するインク供給部及び、

前記電気・機械変換手段を駆動する駆動パルス発生手段を有するインク滴噴射装置において、

前記圧力発生室内に負の圧力を発生させる第１の駆動パルスと、これに続き前記圧力発生室内に正の圧力を発生させる第２の駆動パルスとを含む駆動パルスであって、前記第１の駆動パルスのパルス幅及び前記駆動パルスの印加周期の少なくとも一つが、前記圧力発生室のＡＬ（前記圧力発生室内で発生する圧力波の共振周期の二分の１）の整数倍から実質的にずれるように設定された前記駆動パルスを、前記駆動パルス発生手段が前記電気・機械変換手段に印加して、インク滴を前記ノズルから出射させることを特徴とするインク滴噴射装置。

【請求項２】　前記駆動パルス発生手段は、前記第１の駆動パルスのパルス幅が前記圧力発生室の前記ＡＬより長い前記駆動パルスを発生することを特徴とする請求項１に記載のインク滴噴射装置。

【請求項３】　前記駆動パルス発生手段は、ＡＬ＜Ｗ１＜１．３ＡＬの前記第１の駆動パルスのパルス幅Ｗ１を有する前記第１の駆動パルスを発生することを特徴とする請求項２に記載のインク滴噴射装置。

【請求項４】　前記駆動パルス発生手段は、前記ノズルからの気泡の巻き込みを起こさずに安定に出射することのできる限界飛翔速度が実質的に最大となるパルス幅を有する前記第１の駆動パルスを発生することを特徴とする請求項２に記載のインク滴噴射装置。

【請求項５】　前記駆動パルス発生手段は、前記第１の駆動パルスの実質的に２倍のパルス幅を有する前記第２の駆動パルスを発生することを特徴とする請求項１～４のいずれか１項に記載のインク滴噴射装置。

【請求項６】　前記駆動パルス発生手段は、パルス幅が実質的に２ＡＬである前記第２の駆動パルスを発生することを特徴とする請求項１～４のいずれか１項に記載のインク滴噴射装置。

【請求項７】　前記駆動パルス発生手段は、印加周期が前記ＡＬの整数倍から実質的にずれるように設定された前記駆動パルスを発生することを特徴とする請求項１に記載のインク滴噴射装置。

【請求項８】　前記駆動パルス発生手段は、実質的にｎＡＬ＜Ｔ＜（ｎ＋２／３）ＡＬ（但し、ｎは３以上の整数）の範囲で設定された前記印加周期Ｔを有する前記駆動パルスを発生することを特徴とする請求項７に記載のインク滴噴射装置。

【請求項９】　前記駆動パルス発生手段は、前記第１の駆動パルスの実質的に２倍のパルス幅を有する前記第２の駆動パルスを発生することを特徴とする請求項７又は請求項８に記載のインク滴噴射装置。

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【請求項１０】　前記駆動パルス発生手段は、実質的に２ＡＬであるパルス幅を有する前記第２の駆動パルスを発生することを特徴とする請求項７又は請求項８に記載のインク滴噴射装置。

【請求項１１】　前記電気・機械変換手段には、第１電極及び第２電極が設けられ、前記駆動パルス発生手段は、前記第１電極に対して前記第１の駆動パルスを、前記第２電極に対して前記第１の駆動パルスと同極性の前記第２の駆動パルスを印加することを特徴とする請求項１～１０のいずれか１項に記載のインク滴噴射装置。

【請求項１２】　前記駆動パルス発生手段は、２μｓ以下の立ち上がり・たち下がり時間の矩形波からそれぞれなる前記第１の駆動パルス及び前記第２の駆動パルスを印加することを特徴とする請求項１～１１のいずれか１項に記載のインク滴噴射装置。

【請求項１３】　前記駆動パルス発生手段は、パルス幅の１／４以下の立ち上がり・たち下がり時間の矩形波からそれぞれなる前記第１の駆動パルス及び前記第２の駆動パルスを印加することを特徴とする請求項１～１１のいずれか１項に記載のインク滴噴射装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、インク滴を噴射して記録材に付着させ、画像を形成するインク滴噴射装置、特に、ドロップーオンーデマンドでインク滴を噴射するインク滴噴射装置に関する。

【０００２】

【従来の技術】ドロップーオンーデマンドでインク滴を噴射するインク滴噴射装置は現在広く使用されているが、高速作動と画質の向上が望まれており、そのための研究開発が行われている。

【０００３】インク滴噴射装置は、電気・機械変換手段と、該電気・機械変換手段の作動により圧力を発生する圧力発生室と、該圧力発生室の一端に形成され、圧力の作用により液滴を出射するノズルと、前記圧力発生室にインクを供給するインク供給部とを構成要素とし、電気・機械変換手段に駆動パルスを印加することにより、圧力発生室に発生した圧力でノズルからインク滴を噴射する装置である。

【０００４】インク滴噴射装置は種々の方式が提案されているが、その一つに剪断モードのインク滴噴射装置があり、特許第２９６９５７０号などの公報に記載されている。これらのインク滴噴射装置においては、圧力発生室の音響的共振を利用して、最初に圧力発生室の容積を拡大し、続いて縮小させる連続する２パルスから成る駆動パルスを圧力発生室の音響的共振周期に適合させて印加し、駆動パルスの第１パルス及び第２パルスを併せてインク滴の噴射に利用する方法が用いられている。即

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ち、第１パルスのパルス幅を後に説明する音響的共振周期の１／２であるＡＬとし、第２パルスのパルス幅を２ＡＬとして、このような駆動パルスを用いて電気・機械変換手段である圧電素子を駆動すると、効率よくインク滴を噴射することができるとして使用されている。

【０００５】

【発明が解決しようとする課題】複数のパルスの内の１番目に印加される第１の駆動パルスのパルス幅をＡＬに設定すると一定の駆動電圧に対する出射速度が最大となり、エネルギー効率よく液滴を出射させることができる。しかし、使用するインクの粘度が低い場合、高周波数で液滴を出射する場合、大きな液滴量を出射する場合などにおいて、安定に出射できる液滴速度限界が低くなるという問題があり、さらに高いインク滴速度まで安定に出射できる駆動方法が望まれていた。

【０００６】また、インク滴の出射周期もＡＬの整数倍に設定すると、連続する出射による圧力発生室内の音響振動の位相が整合して安定でかつ効率的な駆動ができるとされている。しかしながら、通常、インクジェット記録装置においては、インク滴の出射周期は、インク滴噴射装置を搭載したキャリッジが走査されるときのエンコーダ信号により決定されるが、キャリッジの走査速度が変動した場合に液滴の出射周期が変動し、これによりインク滴速度、液滴量、出射状態が不安定になるという問題があり、より安定な駆動条件が望まれた。

【０００７】本発明は、従来のインク滴噴射装置における前記のような問題を解決して、高速駆動が可能であり、高画質の画像を形成することができるインク滴噴射装置を提供することを目的とする。

【０００８】

【課題を解決するための手段】前記の本発明の目的は下記の発明のいずれかにより達成される。

【０００９】１．電気・機械変換手段、該電気・機械変換手段の作動により圧力を発生する圧力発生室、該圧力発生室の一端に形成され、圧力の作用によりインク滴を出射するノズル、前記圧力発生室にインクを供給するインク供給部及び、前記電気・機械変換手段を駆動する駆動パルス発生手段を有するインク滴噴射装置において、前記圧力発生室内に負の圧力を発生させる第１の駆動パルスと、これに続き前記圧力発生室内に正の圧力を発生させる第２の駆動パルスとを含む駆動パルスであって、前記第１の駆動パルスのパルス幅及び前記駆動パルスの印加周期の少なくとも一つが、前記圧力発生室のＡＬ（前記圧力発生室内で発生する圧力波の共振周期の二分の１）の整数倍から実質的にずれるように設定された前記駆動パルスを、前記駆動パルス発生手段が前記電気・機械変換手段に印加して、インク滴を前記ノズルから出射させることを特徴とするインク滴噴射装置。

【００１０】２．前記駆動パルス発生手段は、前記第１の駆動パルスのパルス幅が前記圧力発生室の前記ＡＬより長い前記駆動パルスを発生することを特徴とする前記１に記載のインク滴噴射装置。

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【００１１】３．前記駆動パルス発生手段は、ＡＬ＜Ｗ１＜１．３ＡＬの前記第１の駆動パルスのパルス幅Ｗ１を有する前記第１の駆動パルスを発生することを特徴とする前記２に記載のインク滴噴射装置。

【００１２】４．前記駆動パルス発生手段は、前記ノズルからの気泡の巻き込みを起こさずに安定に出射することのできる限界飛翔速度が実質的に最大となるパルス幅を有する前記第１の駆動パルスを発生することを特徴とする前記２に記載のインク滴噴射装置。

【００１３】５．前記駆動パルス発生手段は、前記第１の駆動パルスの実質的に２倍のパルス幅を有する前記第２の駆動パルスを発生することを特徴とする前記１～４のいずれか１項に記載のインク滴噴射装置。

【００１４】６．前記駆動パルス発生手段は、パルス幅が実質的に２ＡＬである前記第２の駆動パルスを発生することを特徴とする前記１～４のいずれか１項に記載のインク滴噴射装置。

【００１５】７．前記駆動パルス発生手段は、印加周期が前記ＡＬの整数倍から実質的にずれるように設定された前記駆動パルスを発生することを特徴とする前記１に記載のインク滴噴射装置。

【００１６】８．前記駆動パルス発生手段は、実質的にｎＡＬ＜Ｔ＜（ｎ＋２／３）ＡＬ（但し、ｎは３以上の整数）の範囲で設定された前記印加周期Ｔを有する前記駆動パルスを発生することを特徴とする前記７に記載のインク滴噴射装置。

【００１７】９．前記駆動パルス発生手段は、前記第１の駆動パルスの実質的に２倍のパルス幅を有する前記第２の駆動パルスを発生することを特徴とする前記７又は前記８に記載のインク滴噴射装置。

【００１８】１０．前記駆動パルス発生手段は、実質的に２ＡＬであるパルス幅を有する前記第２の駆動パルスを発生することを特徴とする前記７又は前記８に記載のインク滴噴射装置。

【００１９】１１．前記電気・機械変換手段には、第１電極及び第２電極が設けられ、前記駆動パルス発生手段は、前記第１電極に対して前記第１の駆動パルスを、前記第２電極に対して前記第１の駆動パルスと同極性の前記第２の駆動パルスを印加することを特徴とする前記１～１０のいずれか１項に記載のインク滴噴射装置。

【００２０】１２．前記駆動パルス発生手段は、２μｓ以下の立ち上がり・たち下がり時間の矩形波からそれぞれなる前記第１の駆動パルス及び前記第２の駆動パルスを印加することを特徴とする前記１～１１のいずれか１項に記載のインク滴噴射装置。

【００２１】１３．前記駆動パルス発生手段は、パルス幅の１／４以下の立ち上がり・たち下がり時間の矩形波からそれぞれなる前記第１の駆動パルス及び前記第２の

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駆動パルスを印加することを特徴とする前記１～１１のいずれか１項に記載のインク滴噴射装置。

【００２２】

【発明の実施の形態】本発明の実施の形態に係るインク滴噴射装置の一例を図１及び図２に示す。

【００２３】図１は本発明の実施の形態に係るインク滴噴射装置の模式図、図２は該インク滴噴射装置の作動を示す図である。

【００２４】図１において、１はインクチューブ、２はノズル形成部材、３はノズル、Ｓは電気・機械変換手段としての側壁、６はカバープレート、７はインク供給口、８は基板である。そして、図２に示すようにインク流路である圧力発生室Ａは側壁Ｓとカバープレート６及び基板８によって形成されている。またノズルは各圧力発生室に形成されているが、図２の一部では省略してある。

【００２５】図１には１個のノズルを有する１個の圧力発生室の断面図が示されているが、実際の剪断モードで動作するインク滴噴射装置Ｈでは、図２（ａ）に示すようにカバープレート６と基板８の間には複数の電気・機械変換手段としての側壁Ｓ、即ち、Ｓ１、Ｓ２・・Ｓｎ＋１で隔てられた圧力発生室Ａ、即ち、Ａ１、Ａ２、・・Ａｎが多数構成されている。圧力発生室Ａ１、Ａ２、・・・Ａｎの一端はノズル形成部材２に形成されたノズル３につながり、他端はインク供給部を構成する供給口７及びインクチューブ１によって図示されていないインクタンクに接続されていて、ノズル３にはインクによるインクメニスカスを形成している。そして、例えば側壁Ｓ１には密着形成された電極Ｑ１、Ｑ２、と側壁Ｓ２に密着形成された電極Ｑ３、Ｑ４が設けてある。同様に各側壁にはそれぞれ電極が密着形成されている。図２（ｂ）に示すように、例えば、第２電極としての電極Ｑ１をアースに接続するとともに、第１電極としての電極Ｑ２を駆動パルス発生手段としての駆動パルス発生回路ＤＲＣに接続して、図７に示すような、波高値Ｖ１、パルス幅Ｗ１で正電圧の第１の駆動パルスであるパルスＰ１、波高値Ｖ２、パルスＷ２で負電圧の第２の駆動パルスであるパルスＰ２及びゼロ電圧の期間Ｅからなる駆動パルスＰ０を印加する。図７の駆動パルスＰ０は電圧Ｖ１とＶ２の絶対値が等しいが、電圧Ｖ１とＶ２とは等しいことが条件とはならない。同様に、第２電極としての電極Ｑ４をアースに接続し、第１電極としての電極Ｑ３に駆動パルスＰ０を印加すると、以下述べる動作によってインク滴をノズル３から飛翔する。図７に示す駆動パルスＰ０は従来技術では、圧力発生室Ａの音響的な共振周期の二分の一をＡＬ（時間）とすると、通常、駆動パルスＰ０において、第１パルスＰ１のパルス幅Ｗ１は実質的にＡＬに等しく、続く第２パルスＰ２のパルス幅Ｗ２は実質的に２ＡＬに等しく、ゼロ（アース）電圧の期間Ｅのパルス幅が実質的にＡＬの整数倍（例えば２ＡＬ）に等しく構成されていた。このような駆動パルスＰ０の構成によって、圧力発生室Ａが効率よく作動し、インクの飛翔速度が最大となる。ＡＬは圧力発生室の長さに対応している。

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【００２６】側壁Ｓ１、Ｓ２、・・・は図２の矢印で示すように分極方向が異なる２個の圧電材料から成る側壁Ｓ１ａ、Ｓ２ａ、・・・とＳ１ｂ、Ｓ２ｂ、・・・とから構成されている。電極Ｑ２及びＱ３に駆動パルスが印加されない時は図２（ａ）のように側壁Ｓ１、Ｓ２は変形しないが、第１パルスＰ１が電極Ｑ２及びＱ３に印加されると、圧電材料の分極方向に直角な方向の電界が生じ、側壁Ｓ１ａ、Ｓ１ｂともに側壁の接合面にズリ変形を生じ、また側壁Ｓ２ａ、Ｓ２ｂも同様に反対方向にズリ変形を生じて、図２（ｂ）に示すように側壁Ｓ１ａ、Ｓ１ｂ及び側壁Ｓ２ａ、Ｓ２ｂは互いに外側に向けて変形し、この例では圧力発生室Ａ１の容積を拡大して圧力室Ａ１内に負の圧力が生ずる。次に、図２（ｃ）に示すように、続く第２パルスＰ２により側壁Ｓ１ａ、Ｓ１ｂ及びＳ２ａ、Ｓ２ｂは互いに逆方向に変形して、圧力発生室Ａ１の容積は急激に縮小して、圧力発生室Ａ１内に正の圧力を生じて、圧力発生室Ａ１を満たしているインクの一部によるノズル３内のインクメニスカスを変化させ、インク滴をノズル３から射出する。各圧力発生室も同様に駆動パルスの印加によって動作し、インク滴を吐出する。

【００２７】前記のように圧力発生室Ａ１の側壁Ｓ１及びＳ２が変形の動作をすると、隣の圧力発生室Ａ２が影響を受けるため、通常、例えば、Ａ１、Ａ４、Ａ７・・・を同一周期のパルスで駆動し、次の周期でＡ２、Ａ５、Ａ８・・・を駆動する方法が行われている。

【００２８】上記インク滴の飛翔は圧力発生室の音響的共振（以下共振と記す）を利用して、最初に第１の駆動パルスとしての正電圧のパルスＰ１によって圧力発生室容積を拡大し、続く第２の駆動パルスとしてのパルスＰ２によって圧力発生室容積を縮小させてインク滴を飛翔させる方法が用いられている。即ち、従来技術においては、パルスＰ１のパルス幅Ｗ１を圧力発生室Ａ１、Ａ２、・・・の共振周期の二分の一であるＡＬに、パルスＰ２のパルス幅Ｗ２を２ＡＬに、電圧ゼロの期間Ｅの長さをＡＬに、それぞれ実質的に等しくすることにより、インクの飛翔効率を高めることが、通常行われている。

【００２９】このように、一般に圧力発生室が単純な空洞構造で、電気・機械変換手段の駆動により発生した圧力が圧力波として圧力発生室内で伝搬、反射を繰り返して音響的共振をおこす場合においては、電気・機械変換手段の駆動をこの音響的共振周期の１／２の間隔、即ち、ＡＬで行なうと音響的共振を利用した効率的な駆動ができるため、駆動波形のパルス幅、駆動周期を実質的にＡＬの整数倍に設定して駆動することが多く行われている。

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【００３０】このような音響的共振を利用した駆動を行なうためには、電気・機械変換手段の駆動により発生する圧力が圧力波として伝搬する必要があり、図７に示すように電気・機械変換手段に印加される駆動波形は音響的共振周期に比べて十分に短い立ち上がり時間ΔＴ及び立ち下がり時間δＴを持った矩形波によって構成されなければならない。前記矩形波の立ち上がり・たち下がり時間、ΔＴ、δＴは前記矩形波のパルス幅との関係では、パルス幅の１／４以下の値に設定することが好ましい。

【００３１】また、インク滴の飛翔によってノズル３及び圧力発生室Ａ１、Ａ２、・・・内のインク量は減少するが、該インク量の減少分はノズル３とインクの毛細管力によってインク供給部としてのインクチューブ１、インク流入口７から圧力発生室Ａ１、Ａ２、・・・へインクが補給される。

【００３２】このような本発明の実施の形態の機械的な構成の一例は図１、２に示すものであるが、他の例として、図３、４、５、６に示すものがある。

【００３３】図３はインク滴噴射装置の圧力発生室のインク流路に沿った断面図である。図１に示す部品と同一の部品は同一の符号を付す。

【００３４】図３におけるＬは圧力発生室Ａの長さであり、圧力発生室Ａの音響的共振周期の二分の一であるＡＬは、ＡＬ≒Ｌ／ＡＣで表される。ＡＣは圧力発生室内の圧力波の速度である。なお、圧力発生室Ａの長さは図３の幾何学的な長さＬにぴったり一致するものではなく、圧力発生室Ａ、即ち、Ａ１、Ａ２、・・・の実効的な長さである。前記式中の≒はこのような意味を含んでいる。

【００３５】圧力発生室ＡのＡＬは、インク滴噴射装置の電気・機械変換手段としての側壁Ｓに矩形波を印加して出射するインク滴の速度を測定し、矩形波の電圧値を一定にして矩形波のパルス幅を変化させたときに、インク滴の飛翔速度が最大になるパルス幅として求められる。

【００３６】図３に示すインク滴噴射装置の圧力発生室の配列及び駆動パルスの印加時における各圧力発生室の作動を図４に示す。

【００３７】圧力発生室、即ち、Ａ１、Ａ２、・・・は空隙として形成されたエアチャネルＤを挟んで形成され、圧力発生室Ａを形成する圧電材料で構成された電気・機械変換手段としての側壁Ｓには第１電極としての電極Ｑａが形成され、エアチャネルＤを形成する側壁には第２電極としての電極Ｑｄが形成される。

【００３８】先ず、図４（ｂ）に示すように、第１段階として、圧力発生室Ａの容積を拡大し、圧力室Ａ内に負の圧力を発生させる正電圧＋Ｖの第１の駆動パルスとしてのパルスＰ１が電極Ｑａに印加される。次いで、図５（ａ）に示すように、圧力発生室Ａの容積を縮小し、圧力室Ａ内に正の圧力を発生させる負電圧－Ｖの第２の駆動パルスとしてのパルスＰ２が電極Ｑａに印加される。

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【００３９】このように、パルスＰ１とＰ２からなる駆動パルスＰ０を電極Ｑａに印加することにより、インク滴がノズル３から出射される。

【００４０】図６（ａ）（ｂ）は前述の圧力発生室Ａの駆動における電極Ｑａ、Ｑｄの電圧を示す。図６（ａ）（ｂ）から明らかなように、この駆動においては、電極Ｑａに正のパルスＰ１と負のパルスＰ２が印加される。

【００４１】インク滴噴射装置の駆動方法として次に説明する他の方法がある。図６（ｃ）（ｄ）は該他の方法における電極ＱａとＱｄの電圧を示し、この方法においては、図６（ｃ）（ｄ）に示すように、正電圧のパルスＰ１を電極Ｑａに印加する一方、電極Ｑｄに正電圧のパルスＰ２を印可する。

【００４２】圧力発生室Ａの容積の拡大は前記の図６（ａ）に示す場合と同様にして行われ、圧力発生室Ａの容積を縮小する駆動段階においては、図５（ｂ）に示すように、エアチャネルの電極Ｑｄに＋Ｖ正電圧を印加することにより、電極Ｑａに負電圧を印加した図５（ａ）の場合と同様な効果で駆動を行っている。

【００４３】図５（ｂ）と図６（ｃ）（ｄ）に示す駆動方法は正電圧のみのパルスを用いて駆動できる点で回路の設計上有利である。

【００４４】本発明の実施の形態においては、駆動パルス発生手段としてのパルス発生回路ＤＲＣにより側壁Ｓに印加される駆動パルスＰ０がパルスＰ１及びそれに続くパルスＰ２を含む。そして、パルスＰ１のパルス幅及び駆動パルスＰ０の印加周期の少なくとも一つを圧力発生室Ａの共振周期の二分の一であるＡＬの整数倍から実質的に外して設定している。

【００４５】これによって、安定に出射できる液滴速度限界が高くなりより安定な出射状態の実現が可能になり、また、駆動パルスの印加周期の変動に対して、インク滴の飛翔速度の変動が少なく、記録材上において、大きさ、位置の変動が少ないドットが形成されて高い画質の画像を形成することが可能になる。

【００４６】特に、パルスＰ１のパルス幅Ｗ１をＡＬよりも大きく設定することが望ましく、また、パルスＰ１のパルス幅Ｗ１をＡＬ＜Ｗ１＜１．３ＡＬとすることにより、インク滴の飛翔速度の限界値を高くすることが可能になり、インク滴の飛翔を一層安定させ、より良好な画像を形成することが可能になる。パルスＰ１のパルス幅Ｗ１が前記の不等式の範囲を外れると、前記飛翔速度の限界値が低くなる。

【００４７】また、本発明の実施の形態の他の特徴は、インク滴の飛翔を高度に安定させて高画質の画像記録を可能にすることであり、パルスＰ１のパルス幅を、ノズル３から空気の巻き込みを起こすことなくインク滴を出射することができる液滴速度限界値が極大になるパルス

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幅に設定することにより実現される。

【００４８】パルスＰ２のパルス幅の設定により、パルスＰ１により発生した圧力波を液滴出射後に打ち消し沈静化することができる。本実施の形態においては、パルスＰ１の実質的に２倍のパルス幅を有するパルスＰ２を印加することにより、パルスＰ１により発生した圧力波を液滴出射後に有効に打ち消し沈静化できることが確認された。さらに好ましくは、パルスＰ２のパルス幅は実質的に２ＡＬとなるように設定することにより、より安定な液滴出射が可能になる。

【００４９】更に、パルスＰ１のパルス幅をＡＬよりも大きく設定するという手段の他に、駆動パルスＰ０の印加周期をＡＬの整数倍から実質的にずらして設定することによっても、インク滴の飛翔を安定させ、高画質の画像を形成することが可能である。

【００５０】特に、駆動パルスＰ０の印加周期ＴがｎＡＬ＜Ｔ＜（ｎ＋２／３）ＡＬ（但し、ｎは３以上の整数）であるときに、インク滴の飛翔が安定し、高画質が得られる。駆動パルスＰ０の印加周期が前記の不等式の範囲外になると、キャリッジの走査速度の変動に起因する駆動パルスの印加周期の変動の影響がインク滴の飛翔速度に現れ易くなる傾向が出る。

【００５１】パルスＰ１のパルス幅をＡＬよりも大きく設定するという手段と駆動パルスＰ０の印加周期をＡＬの整数倍に実質的に等しくないように設定するという手段はそれぞれ単独で用いても、また、両者を併せて用いても効果的であり、高画質の画像を形成することができる。

【００５２】

【実施例】圧力発生室の特性値であるＡＬ、即ち、圧力発生室の音響的な共振周期の１／２の値は、上記駆動波形で繰り返し周期Ｔを十分長くとった駆動パルスをインク滴噴射装置の圧電素子に印加し、矩形波の電圧値Ｖを一定にして矩形波のパルス幅Ｗ１を変化させたときのインク滴の速度を測定することにより、インク滴の速度が最大になるパルス幅として求められる。

【００５３】実施例１

本実施例のインク滴噴射装置の特性値ＡＬは、図８に示す測定結果から８．８μｓであった。即ち、駆動波形のパルス幅Ｗ１をこのＡＬに設定することにより駆動電圧に対して最も効率的に液滴速度が得られる。

【００５４】図３に示すインク滴噴射装置Ｈに、上記駆動波形で繰り返し周期Ｔを５ＡＬとし、矩形波のパルス幅Ｗ１を変化させ、それぞれのパルス幅の駆動波形において駆動電圧値Ｖを上げてゆき、ノズルからの気泡の巻き込みを起こす直前の出射可能な限界液滴速度を測定した結果を図９に示す。限界液滴速度はパルス幅Ｗ１をＡＬよりも大きくした９．７μｓ（１．１ＡＬ）で最大となり、ＡＬ＜Ｗ１＜１．３ＡＬの範囲において、Ｗ１をＡＬに設定した場合よりもより大きな液滴速度まで安定

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に出射することができた。

【００５５】実施例２

圧力発生室の特性値であるＡＬが４．８μｓの液滴噴射装置において、上記駆動波形のパルス幅Ｗ１を５．２μｓに設定し、駆動電圧値Ｖを１５Ｖに固定して、繰り返し出射周期Ｔを変化させて出射される液滴の速度及び液滴体積を測定した結果を図１０に示す。この結果から、出射周期（駆動パルスＰ０の印加周期に等しい）が変動した場合にインク滴の飛翔速度及びインク滴の体積の変動を小さくして安定な出射状態を保つには、出射周期の中心値を図の変曲カーブの極大点もしくは極小点である（ｎ＋１／３）ＡＬに設定することが好ましいことがわかる。

【００５６】前記の実施例においては、パルスＰ１及びパルスＰ２の立ち上がり時間ΔＴと立ち下がり時間δＴを０．５μｓの矩形波で構成することにより、前記の条件を満たすことができた。

【００５７】

【発明の効果】請求項１の発明により、高く、且つ安定したインク滴の飛翔速度が実現され、高い画質の画像を高速で形成することが可能になる。

【００５８】請求項２、３又は４の発明により、特に、インク滴を高速で飛翔させることが可能になり、高画質の画像を安定に形成することが可能になる。

【００５９】請求項５又は６の発明により、特に、インク滴を連続で高速に飛翔させる場合に出射状態を安定に保ち、高画質の画像を安定に形成することが可能になる。

【００６０】請求項７の発明により、キャリッジの走査速度の変動等によるインク滴間隔の変動を抑制することが可能になり、高画質の画像を形成することが可能になる。

【００６１】請求項８の発明により、インク滴間隔の変動が、特に良好に抑制されて高画質の画像を形成することが可能になる。

【００６２】請求項９又は１０の発明により、特に、インク滴を連続で高速に飛翔させる場合に出射状態を安定に保ち、高画質の画像を安定に形成することが可能になる。

【００６３】請求項１１の発明により、高速、且つ、高画質の剪断モードインク滴噴射装置が実現され、また、単一極性の電源のみの駆動回路で駆動パルス発生手段を構成することができるので、回路の設計、製造が容易である。

【００６４】請求項１２又は１３の発明により、音響的共振を利用した効率的な駆動が可能となり、駆動にかかる消費電力の低減が可能になる。

【図面の簡単な説明】

【図１】インク滴噴射装置の模式図である。

【図２】インク滴噴射装置の作動を示す図である。

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【図３】インク滴噴射装置の圧力発生室のインク流路に沿った断面図である。
【図４】圧力発生室の作動を示す図である。
【図５】圧力発生室の作動を示す図である。
【図６】駆動パルスを示す図である。
【図７】駆動パルスの波形を示した図である。
【図８】第１の駆動パルスのパルス幅とインク滴の飛翔速度の関係を示すグラフである。
【図９】第１の駆動パルスのパルス幅とインク滴の限界飛翔速度の関係を示すグラフである。
【図１０】駆動パルスの印加周期とインク滴の飛翔速度及びインク滴の体積の関係を示すグラフである。

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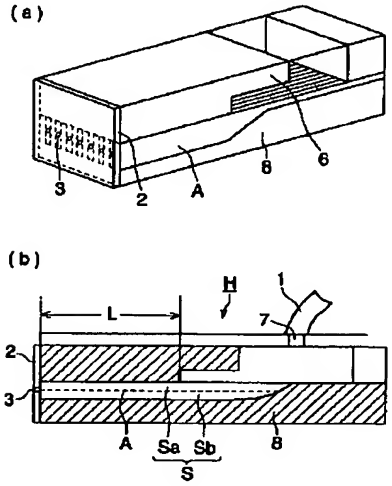
【符号の説明】
１　インクチューブ
３　ノズル
４　インクメニスカス
７　インク供給口
８　基板
Ａ，Ａ１，Ａ２　圧力発生室
Ｈ　インク滴噴射装置
Ｐ０　駆動パルス
Ｐ１　第１パルス
Ｐ２　第２パルス

【図１】



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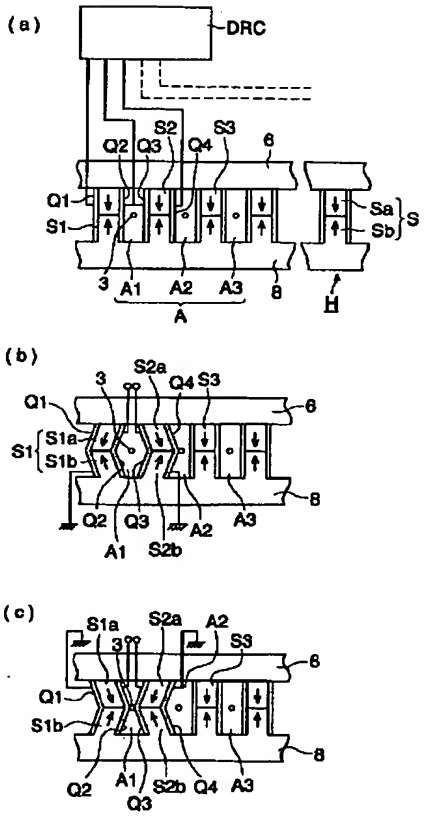

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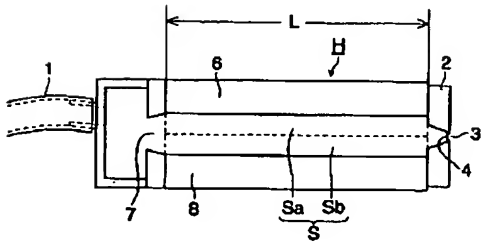

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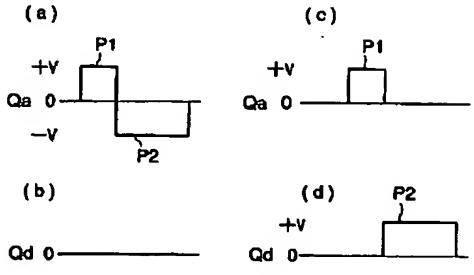

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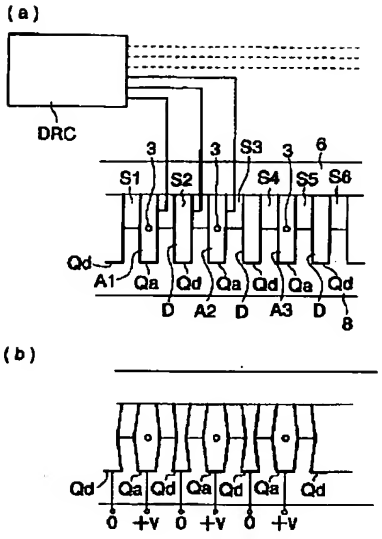

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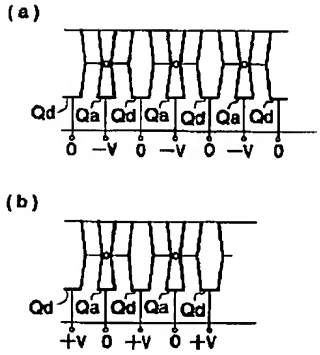

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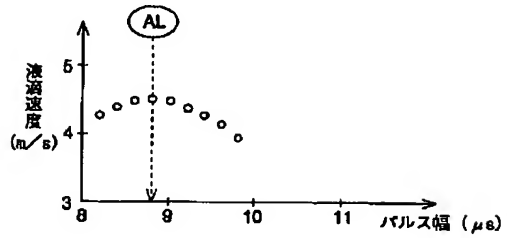

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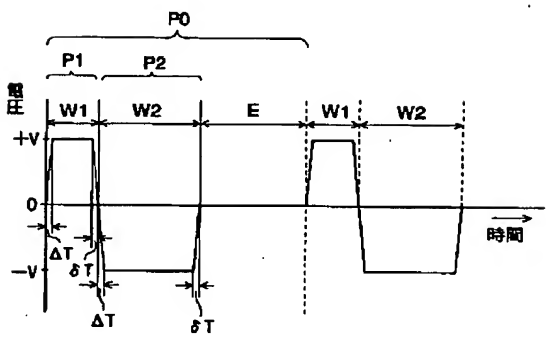

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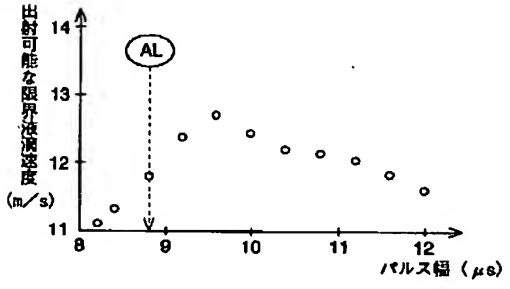

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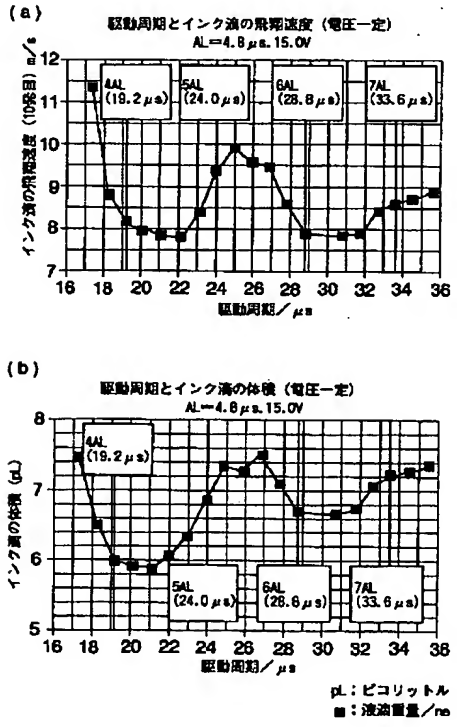

INK DROP PROJECTOR

Patent Number: JP2001315330
Publication date: 2001-11-13
Inventor(s): ASANO KAZUO; KITAMI AKIKO
Applicant(s): KONICA CORP
Requested Patent: ☐ JP2001315330
Application Number: JP20000139852 20000512
Priority Number(s):
IPC Classification: B41J2/045; B41J2/055
EC Classification:
Equivalents:

Abstract

PROBLEM TO BE SOLVED: To solve the problem of conventional driving method for an ink drop ejector where the pulse width and application period of a pulse for driving an electromechanical conversion means are set equal to an integer times of AL, which is equal to one half of the acoustic resonance period of a pressure generating chamber, that the operation is unstable when the ejector is driven with a high frequency.
SOLUTION: The driving pulse is set such that at least one of the pulse width and application period thereof is substantially not equal to an integer times of AL.

特実：　Ｐ 特許　　出願番号：　特願２０００－１３９８５２（平成１２年（２０００）５月１２日）
公開番号：　特開２００１－３１５３３０（平成１３年（２００１）１１月１３日）
公告番号：
登録番号：
出願人　：　コニカ株式会社　　(1)
発明名称　：　インク滴噴射装置

要約文　：　【課題】　電気・機械変換手段を駆動する駆動パルスのパルス幅や印加周期を圧力発生室の音響的共振周期の二分の一であるＡＬの整数倍に設定する従来のインク滴噴射装置の駆動方法では、高周波駆動において、安定に欠ける等の問題があった。【解決手段】　駆動パルスのパルス幅及び印加周期の少なくとも一つがＡＬの整数倍に実質的に等しくないように、駆動パルスを設定する。

公開ＩＰＣ：　*B41J2/045、IB41J2/055
公告ＩＰＣ：
フリーＫＷ：　インク滴　噴射　装置，負，圧力，発生，駆動　パルス，パルス幅，印加，周期，１つ，圧力　発生室，圧力波，共振　周期，２分，１，整数倍，安定，インク滴，飛行　速度，高さ，画質，高速
自社分類　：
自社ｷｰﾜｰﾄﾞ：
最終結果　：
関連出願　：　(0)

審判　：
審決　：
対応出願　：　(0)

中間記録

受付発送日	種別	料担ｺｰﾄﾞ	条文	受付発送日	種別	料担ｺｰﾄﾞ	条文
2000/05/12	63 出願書類	21000		2000/05/16	ZS 他庁審査処		

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B41J 2/055

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(71)Applicant : KONICA CORP

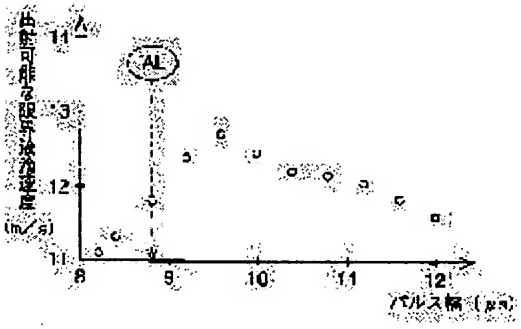
(72)Inventor : ASANO KAZUO
KITAMI AKIKO

(54) INK DROP PROJECTOR

(57)Abstract:

PROBLEM TO BE SOLVED: To solve the problem of conventional driving method for an ink drop ejector where the pulse width and application period of a pulse for driving an electromechanical conversion means are set equal to an integer times of AL, which is equal to one half of the acoustic resonance period of a pressure generating chamber, that the operation is unstable when the ejector is driven with a high frequency.

SOLUTION: The driving pulse is set such that at least one of the pulse width and application period thereof is substantially not equal to an integer times of AL.



LEGAL STATUS

[Date of request for examination]

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[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

* NOTICES *

CLAIMS

[Claim(s)]
[Claim 1] A pressure generating room which generates a pressure by actuation of electrical and electric equipment and a machine conversion means, and this electrical and electric equipment and machine conversion means, A nozzle which is formed in an end of this pressure generating room, and carries out outgoing radiation of the ink drop according to an operation of a pressure, In an ink drop fuel injection equipment which has an ink feed zone which supplies ink to said pressure generating room, and a driving pulse generating means to drive said electrical and electric equipment and machine conversion means It is a driving pulse containing the 1st driving pulse which makes said pressure generating interior of a room generate negative pressure, and the 2nd driving pulse which generates a positive pressure at said pressure generating interior of a room following this. At least one of pulse width of said 1st driving pulse and the impression periods of said driving pulse Said driving pulse generating means impresses said driving pulse set up so that it might shift from an integral multiple of AL (1 of bisection of a resonant period of a pressure wave generated in said pressure generating interior of a room) of said pressure generating room substantially to said electrical and electric equipment and machine conversion means. An ink drop fuel injection equipment characterized by carrying out outgoing radiation of the ink drop from said nozzle.
[Claim 2] Said driving pulse generating means is an ink drop fuel injection equipment according to claim 1 characterized by generating said driving pulse with pulse width of said 1st driving pulse longer than said AL of said pressure generating room.
[Claim 3] Said driving pulse generating means is an ink drop fuel injection equipment according to claim 2 characterized by generating said 1st driving pulse which has pulse width W1 of said 1st driving pulse of AL<W1<1.3AL.
[Claim 4] Said driving pulse generating means is an ink drop fuel injection equipment according to claim 2 characterized by generating said 1st driving pulse which has pulse width from which marginal flight speed which can carry out outgoing radiation to stability, without starting contamination of air bubbles from said nozzle serves as max substantially.
[Claim 5] Said driving pulse generating means is an ink drop fuel injection equipment given in any 1 term of claims 1-4 characterized by generating said 2nd driving pulse of said 1st driving pulse which has twice as many pulse width as this substantially.
[Claim 6] Said driving pulse generating means is an ink drop fuel injection equipment given in any 1 term of claims 1-4 characterized by generating said 2nd driving pulse whose pulse width is 2AL(s) substantially.
[Claim 7] Said driving pulse generating means is an ink drop fuel injection equipment according to claim 1 characterized by generating said driving pulse set up so that an impression period might shift from said integral multiple of AL substantially.
[Claim 8] Said driving pulse generating means is an ink drop fuel injection equipment according to claim 7 substantially characterized by generating said driving pulse which has said impression period T set up in the range of nAL<T< (n+2/3) AL (however, n three or more integers).
[Claim 9] Said driving pulse generating means is an ink drop fuel injection equipment according to claim 7 or 8 characterized by generating said 2nd driving pulse of said 1st driving pulse which has twice as many pulse width as this substantially.
[Claim 10] Said driving pulse generating means is an ink drop fuel injection equipment according to claim 7 or 8 characterized by generating said 2nd driving pulse which has pulse width which is 2AL(s) substantially.
[Claim 11] It is an ink drop fuel injection equipment given in any 1 term of claims 1-10 which the 1st electrode and the 2nd electrode are prepared in said electrical and electric equipment and machine conversion means, and are characterized by said driving pulse generating means impressing said 1st driving pulse and said 2nd driving pulse of

like-pole nature for said 1st driving pulse to said 2nd electrode to said 1st electrode.
[Claim 12] Said driving pulse generating means is an ink drop fuel injection equipment given in any 1 term of claims 1-11 characterized by impressing a standup, said 1st driving pulse which leaves, falls and consists of a square wave of time amount, respectively, and said 2nd driving pulse for 2 or less microseconds.
[Claim 13] Said driving pulse generating means is an ink drop fuel injection equipment given in any 1 term of claims 1-11 characterized by impressing 1/4 or less standup, said 1st driving pulse which leaves, falls and consists of a square wave of time amount, respectively, and said 2nd driving pulse of pulse width.

[Translation done.]

* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] This invention injects an ink drop, is made to adhere to record material, and relates to the ink drop fuel injection equipment which forms an image, and the ink drop fuel injection equipment which injects an ink drop by drop-on demand especially.
[0002]
[Description of the Prior Art] Although the ink drop fuel injection equipment which injects an ink drop by drop-on demand is used widely now, improvement in a fast operation and image quality is desired, and the research and development for it are done.
[0003] The pressure generating room where an ink drop fuel injection equipment generates a pressure by actuation of the electrical and electric equipment and a machine conversion means, and this electrical and electric equipment and machine conversion means, By being formed in the end of this pressure generating room, using as a component the nozzle which carries out outgoing radiation of the drop according to an operation of a pressure, and the ink feed zone which supplies ink to said pressure generating room, and impressing a driving pulse to the electrical and electric equipment and a machine conversion means It is equipment which injects an ink drop from a nozzle by the pressure generated in the pressure generating room.
[0004] Although various methods are proposed, an ink drop fuel injection equipment has the ink drop fuel injection equipment in shear mode in one of them, and is indicated by official reports, such as patent No. 2969570. The driving pulse which consists of two continuous pulses to which expand, and the capacity of a pressure generating room is made to reduce continuously first in these ink drop fuel injection equipments using acoustical resonance of a pressure generating room is fitted to the acoustical resonant period of a pressure generating room, it impresses, and the method of combining the 1st pulse and the 2nd pulse of a driving pulse, and using for injection of an ink drop is used. That is, if pulse width of the 1st pulse is set to AL which is 1/2 of an acoustical resonant period explained later and the piezoelectric device which are the electrical and electric equipment and a machine conversion means is driven by setting pulse width of the 2nd pulse to 2AL(s) using such a driving pulse, it is used noting that an ink drop can be injected efficiently.
[0005]
[Problem(s) to be Solved by the Invention] If the pulse width of the 1st driving pulse impressed to the 1st of two or more pulses is set as AL, the outgoing radiation speed to fixed driver voltage can serve as max, and energy efficiency can improve a drop outgoing radiation. However, when the viscosity of the ink to be used was low and outgoing radiation of the drop was carried out with high frequency, when carrying out outgoing radiation of the big amount of drops, there is a problem that the drop speed limit which can carry out outgoing radiation to stability becomes low, and the drive method which can carry out outgoing radiation to stability to a still higher ink drop speed was desired.
[0006] Moreover, if the outgoing radiation period of an ink drop is also set as the integral multiple of AL, it is supposed that the phase of the acoustic vibration of the pressure generating interior of a room by continuous outgoing radiation has consistency, and a stable and efficient drive can be performed. However, in the ink jet recording device, although the outgoing radiation period of an ink drop was determined by the encoder signal in case the carriage carrying an ink drop fuel injection equipment is scanned, when the scan speed of carriage is changed, the outgoing radiation period of a drop is changed, there is a problem that ink drop speed, the amount of drops, and an outgoing radiation condition become unstable by this, and more stable drive conditions were usually desired.
[0007] This invention solves the above problems in the conventional ink drop fuel injection equipment, and a high-speed drive is possible and it aims at offering the ink drop fuel injection equipment which can form a high-definition

image.
[0008]
[Means for Solving the Problem] The purpose of aforementioned this invention is attained by either of the following invention.
[0009] 1. Pressure Generating Room Which Generates Pressure by Actuation of Electrical and Electric Equipment and Machine Conversion Means, and this Electrical and Electric Equipment and Machine Conversion Means, A nozzle which is formed in an end of this pressure generating room, and carries out outgoing radiation of the ink drop according to an operation of a pressure, In an ink drop fuel injection equipment which has an ink feed zone which supplies ink to said pressure generating room, and a driving pulse generating means to drive said electrical and electric equipment and machine conversion means It is a driving pulse containing the 1st driving pulse which makes said pressure generating interior of a room generate negative pressure, and the 2nd driving pulse which generates a positive pressure at said pressure generating interior of a room following this. At least one of pulse width of said 1st driving pulse and the impression periods of said driving pulse Said driving pulse generating means impresses said driving pulse set up so that it might shift from an integral multiple of AL (1 of bisection of a resonant period of a pressure wave generated in said pressure generating interior of a room) of said pressure generating room substantially to said electrical and electric equipment and machine conversion means. An ink drop fuel injection equipment characterized by carrying out outgoing radiation of the ink drop from said nozzle.
[0010] 2. Said driving pulse generating means is an ink drop fuel injection equipment given in said 1 characterized by generating said driving pulse with pulse width of said 1st driving pulse longer than said AL of said pressure generating room.
[0011] 3. Said driving pulse generating means is an ink drop fuel injection equipment given in said 2 characterized by generating said 1st driving pulse which has the pulse width W1 of said 1st driving pulse of AL<W1<1.3AL.
[0012] 4. Said driving pulse generating means is an ink drop fuel injection equipment given in said 2 characterized by generating said 1st driving pulse which has pulse width from which marginal flight speed which can carry out outgoing radiation to stability, without starting contamination of air bubbles from said nozzle serves as max substantially.
[0013] 5. Said driving pulse generating means is an ink drop fuel injection equipment given in said any 1 term of 1-4 characterized by generating said 2nd driving pulse of said 1st driving pulse which has twice as many pulse width as this substantially.
[0014] 6. Said driving pulse generating means is an ink drop fuel injection equipment given in said any 1 term of 1-4 characterized by generating said 2nd driving pulse whose pulse width is 2AL(s) substantially.
[0015] 7. Said driving pulse generating means is an ink drop fuel injection equipment given in said 1 characterized by generating said driving pulse set up so that an impression period might shift from said integral multiple of AL substantially.
[0016] 8. Said driving pulse generating means is an ink drop fuel injection equipment given in said 7 substantially characterized by generating said driving pulse which has said impression period T set up in the range of nAL<T< (n+2/3) AL (however, n three or more integers).
[0017] 9. Said driving pulse generating means is an ink drop fuel injection equipment given in said 7 characterized by generating said 2nd driving pulse of said 1st driving pulse which has twice as many pulse width as this substantially, or said 8.
[0018] 10. Said driving pulse generating means is an ink drop fuel injection equipment given in said 7 characterized by generating said 2nd driving pulse which has pulse width which is 2AL(s) substantially, or said 8.
[0019] 11. It is an ink drop fuel injection equipment given in said any 1 term of 1-10 which the 1st electrode and the 2nd electrode are prepared in said electrical and electric equipment and machine conversion means, and is characterized by said driving pulse generating means impressing said 1st driving pulse and said 2nd driving pulse of like-pole nature for said 1st driving pulse to said 2nd electrode to said 1st electrode.
[0020] 12. Said driving pulse generating means is an ink drop fuel injection equipment given in said any 1 term of 1-11 characterized by impressing a standup, said 1st driving pulse which leaves, falls and consists of a square wave of time amount, respectively, and said 2nd driving pulse for 2 or less microseconds.
[0021] 13. Said driving pulse generating means is an ink drop fuel injection equipment given in said any 1 term of 1-11 characterized by impressing 1/4 or less standup, said 1st driving pulse which leaves, falls and consists of a square wave of time amount, respectively, and said 2nd driving pulse of pulse width.
[0022]
[Embodiment of the Invention] An example of the ink drop fuel injection equipment concerning the gestalt of operation of this invention is shown in drawing 1 and drawing 2 .

[0023] The mimetic diagram of the ink drop fuel injection equipment which drawing 1 requires for the gestalt of operation of this invention, and drawing 2 are drawings showing actuation of this ink drop fuel injection equipment.
[0024] drawing 1 -- setting -- 1 -- for a nozzle and S, as for a cover plate and 7, the side wall as the electrical and electric equipment and a machine conversion means and 6 are [an ink tube and 2 / a nozzle formation member and 3 / an ink feed hopper and 8] substrates. And the pressure generating room A which is ink passage as shown in drawing 2 is formed by the side wall S, the cover plate 6, and the substrate 8. Moreover, although the nozzle is formed in each pressure generating room, it has omitted by a part of drawing 2 .
[0025] Although the cross section of one pressure generating room which has one nozzle is shown in drawing 1 In the ink drop fuel injection equipment H which operates in actual shear mode it is shown in drawing 2 (a) -- as -- the side wall S as two or more electrical and electric equipment [between / a cover plate 6 and substrates 8], and a machine conversion means, S1 and S2, .. the pressure generating room, A1 and A2, A separated by Sn+1, and .. much An(s) are constituted. [i.e.,] [i.e.,] the pressure generating rooms A1 and A2 and ... the end of An is connected with the nozzle 3 formed in the nozzle formation member 2, it connects with the ink tank which is not illustrated with the feed hopper 7 and the ink tube 1 which constitute an ink feed zone, and the other end forms the ink meniscus in ink in a nozzle 3. And the electrodes Q1 and Q2 by which adhesion formation was carried out, and the electrodes Q3 and Q4 by which adhesion formation was carried out at the side wall S2 are formed on the side wall S1, for example. Adhesion formation of the electrode is carried out similarly at each side wall, respectively. While connecting the electrode Q1 as the 2nd electrode to a ground as shown in drawing 2 (b) for example The electrode Q2 as the 1st electrode is connected to the driving pulse generating circuit DRC as a driving pulse generating means. The driving pulse P0 which consists of a pulse P2 which is the 2nd driving pulse of negative voltage, and a period E of null voltage by the peak value V1 as shown in drawing 7 , the pulse P1 which is the 1st driving pulse of positive voltage in pulse width W1, peak value V2, and the pulse W2 is impressed. Although the driving pulse P0 of drawing 7 has the equal absolute value of voltage V1 and V2, as for conditions, it does not become that voltage V1 and V2 is equal. If similarly the electrode Q4 as the 2nd electrode is connected to a ground and a driving pulse P0 is impressed to the electrode Q3 as the 1st electrode, an ink drop will be flown from a nozzle 3 by actuation described below. If the driving pulse P0 shown in drawing 7 sets the half of the acoustical resonant period of the pressure generating room A to AL (time amount) with the conventional technology Usually, in the driving pulse P0, the pulse width W1 of the 1st pulse P1 was substantially equal to AL, the pulse width W2 of the 2nd continuing pulse P2 was substantially equal to 2AL(s), and the pulse width of the period E of zero (ground) voltage was constituted equally to the integral multiple (for example, 2AL(s)) of AL substantially. By the configuration of such a driving pulse P0, the pressure generating room A operates efficiently and the flight speed of ink serves as max. AL supports the length of a pressure generating room.
[0026] It consists of side wall S1a, S2a and ... which consist of side walls S1 and S2 and two piezoelectric material with which the directions of polarization differ as the arrow head of drawing 2 shows ..., S1b, S2b, and ... When a driving pulse is not impressed to electrodes Q2 and Q3, side walls S1 and S2 do not deform like drawing 2 (a), but if the 1st pulse P1 is impressed to electrodes Q2 and Q3 The electric field of a right-angled direction arise in the direction of polarization of piezoelectric material, and side wall S1a and S1b produce ZURI deformation in the plane of composition of a side wall. Moreover, side wall S2a and S2b produce ZURI deformation in an opposite direction similarly, as shown in drawing 2 (b), side wall S1a, S1b and side wall S2a, and S2b deform towards an outside mutually, in this example, they expand the capacity of the pressure generating room A1, and negative pressure produces them in the pressure room A1. Next, as shown in drawing 2 (c), side wall S1a, S1b and S2a, and S2b deform into hard flow mutually by the 2nd continuing pulse P2. It reduces rapidly, and the capacity of the pressure generating room A1 produces a positive pressure in the pressure generating room A1, it changes the ink meniscus in the nozzle 3 in some ink which is filling the pressure generating room A1, and injects an ink drop from a nozzle 3. Each pressure generating room operates by impression of a driving pulse similarly, and carries out the regurgitation of the ink drop.
[0027] if the side walls S1 and S2 of the pressure generating room A1 carry out actuation of deformation as mentioned above, in order to influence the next pressure generating room A2 -- usually -- A1, A4, and A7 ... the pulse of the same period -- driving -- the following period -- A2, A5, and A8 -- the method of driving ... is performed. [for example,]
[0028] The method of flight of the above-mentioned ink drop making pressure generating room capacity reduce by the pulse P2 as the 2nd driving pulse which expands pressure generating room capacity and continues by the pulse P1 of the positive voltage as the 1st driving pulse first using acoustical resonance (it is described as resonance below) of a pressure generating room, and making an ink drop fly is used. namely, AL which is the half of the pressure generating rooms A1 and A2 and the resonant period of ... about the pulse width W1 of a pulse P1 in the conventional technology -- the pulse width W2 of a pulse P2 -- 2AL(s) -- the length of the period E of voltage zero -- AL -- respectively -- substantial -- etc. -- the thing to spread, to do and for which the flight effectiveness of ink is raised is usually performed

especially more.
[0029] Thus, generally the pressure generated by the drive of the electrical and electric equipment and a machine conversion means with cavernous structure with a simple pressure generating room spreads as a pressure wave in the pressure generating interior of a room. [when repeating reflection and causing acoustical resonance] Since the efficient drive using acoustical resonance can be performed if the electrical and electric equipment and a machine conversion means are driven at one half of the gaps of this acoustical resonant period, i.e., AL, setting the pulse width of a drive wave and a drive period as the integral multiple of AL substantially, and driving [many] them are performed.
[0030] In order to perform the drive using such acoustical resonance, the pressure generated by the drive of the electrical and electric equipment and a machine conversion means needs to spread as a pressure wave, and the drive wave impressed to the electrical and electric equipment and a machine conversion means as shown in drawing 7 must be constituted by the square wave which had build-up-time deltaT short enough and falling time amount deltaT compared with the acoustical resonant period. It leaves, and it falls and, as for time amount, deltaT, and deltaT, it is desirable the standup of said square wave and to set it as 1/4 or less value of pulse width by relation with the pulse width of said square wave.
[0031] moreover, flight of an ink drop -- a nozzle 3 and the pressure generating rooms A1 and A2, and ... although the inner amount of ink decreases, as for the decrement of this amount of ink, ink is supplied to the pressure generating rooms A1 and A2 and ... according to the capillary tube force of a nozzle 3 and ink from the ink tube 1 as an ink feed zone, and the ink input 7.
[0032] Although an example of the mechanical configuration of the gestalt of operation of such this invention is shown in drawing 1 and 2, there are drawing 3 and a thing shown in 4, 5, and 6 as other examples.
[0033] Drawing 3 is a cross section along the ink passage of the pressure generating room of an ink drop fuel injection equipment. The same components as the components shown in drawing 1 attach the same sign.
[0034] L in drawing 3 is the length of the pressure generating room A, and AL which is the half of the acoustical resonant period of the pressure generating room A is expressed with AL**L/AC. AC is the speed of the pressure wave of the pressure generating interior of a room. In addition, the length of the pressure generating room A is not a match exactly at geometric length L of drawing 3 , but is the pressure generating room, A1 and A2, A and the effectual length of ... [i.e.,] ** in said formula includes such semantics.
[0035] AL of the pressure generating room A measures the speed of the ink drop which impresses and carries out outgoing radiation of the square wave to the side wall S as the electrical and electric equipment and a machine conversion means of an ink drop fuel injection equipment, and when fixing the voltage value of a square wave and changing the pulse width of a square wave, it is calculated as pulse width from which the flight speed of an ink drop becomes max.
[0036] Actuation of each pressure generating room at the time of the array of the pressure generating room of the ink drop fuel injection equipment shown in drawing 3 and impression of a driving pulse is shown in drawing 4 .
[0037] The electrode Qd as the 2nd electrode is formed in the side wall which the electrode Qa as the 1st electrode is formed in the side wall S as the electrical and electric equipment and a machine conversion means which consisted of piezoelectric material which is formed on both sides of the air channel D in which a pressure generating room, A1 and A2, and ... were formed as an opening, and forms the pressure generating room A, and forms the air channel D. [i.e.,]
[0038] First, as shown in drawing 4 (b), as the 1st step, the capacity of the pressure generating room A is expanded and the pulse P1 as the 1st driving pulse of positive voltage +V which generates negative pressure in the pressure room A is impressed to Electrode Qa. Subsequently, as shown in drawing 5 (a), the capacity of the pressure generating room A is reduced and the pulse P2 as the 2nd driving pulse of negative voltage-V which generates a positive pressure in the pressure room A is impressed to Electrode Qa.
[0039] Thus, outgoing radiation of the ink drop is carried out from a nozzle 3 by impressing the driving pulse P0 which consists of pulses P1 and P2 to Electrode Qa.
[0040] Drawing 6 (a) and (b) show the voltage of the electrodes Qa and Qd in the drive of the above-mentioned pressure generating room A. In this drive, the positive pulse P1 and the negative pulse P2 are impressed to Electrode Qa so that clearly from drawing 6 (a) and (b).
[0041] There are other methods explained below as the drive method of an ink drop fuel injection equipment. Drawing 6 (c) and (d) show the voltage of the electrodes Qa and Qd in these other methods, and as shown in drawing 6 (c) and (d), while they impress the pulse P1 of positive voltage to Electrode Qa in this method, they carry out the seal of approval of the pulse P2 of positive voltage to Electrode Qd.
[0042] Expansion of the capacity of a pressure generating room A is performed like the case are shown in aforementioned drawing 6 (a), and as the capacity of a pressure generating room A is shown in drawing 5 (b) in the

drive phase reduce, it is driving by the same effect as the case of drawing 5 (a) which impressed negative voltage to an electrode Qa by impressing +V positive voltage to the electrode Qd of an air channel.
[0043] The drive method shown in drawing 5 (b), drawing 6 (c), and (d) is advantageous on layout of a circuit at the point which can be driven using the pulse of only positive voltage.
[0044] In the gestalt of operation of this invention, the driving pulse P0 impressed to a side wall S by pulse generating circuit DRC as a driving pulse generating means includes the pulse P2 following a pulse P1 and it. And from the integral multiple of AL which is the half of the resonant period of the pressure generating room A, at least one of the pulse width of a pulse P1 and the impression periods of a driving pulse P0 was removed substantially, and it is set up.
[0045] the drop speed limit which can carry out outgoing radiation to stability by this -- high -- collapsibility -- implementation of a stable outgoing radiation condition is attained, and to fluctuation of the impression period of a driving pulse, there is little fluctuation of the flight speed of an ink drop, and it becomes possible to form magnitude and a dot with little fluctuation of a location on record material, and to form the image of high image quality.
[0046] It is desirable to set up more greatly than AL the pulse width W1 of a pulse P1 especially, and by setting pulse width W1 of a pulse P1 to AL<W1<1.3AL, it becomes possible to make high threshold value of the flight speed of an ink drop, and flight of an ink drop is stabilized further and it becomes possible to form a better image. If it separates from the range of the inequality of the above [the pulse width W1 of a pulse P1], the threshold value of said flight speed will become low.
[0047] Moreover, other features of the gestalt of operation of this invention are stabilizing flight of an ink drop in altitude and making high-definition image recording possible, and they are realized by setting an ink drop as the pulse width from which the drop speed-limit value which can carry out outgoing radiation becomes the maximum, without starting the contamination of air for the pulse width of a pulse P1 from a nozzle 3.
[0048] By setup of the pulse width of a pulse P2, the pressure wave generated by the pulse P1 can be negated after drop outgoing radiation, and it can become calm. In the gestalt of this operation, it was checked by impressing the pulse P2 of a pulse P1 which has twice as many pulse width as this substantially that the pressure wave generated by the pulse P1 is negated effectively after drop outgoing radiation, and it can become calm. More stable drop outgoing radiation becomes possible still more preferably by setting up so that the pulse width of a pulse P2 may serve as 2AL(s) substantially.
[0049] Furthermore, it is possible to stabilize flight of an ink drop and to form a high-definition image also by shifting substantially the impression period of a driving pulse P0 other than a means to set up the pulse width of a pulse P1 more greatly than AL, and setting it up from the integral multiple of AL.
[0050] Especially, when the impression period T of a driving pulse P0 is nAL<T<(n+2/3) AL (however, n three or more integers), flight of an ink drop is stabilized and high definition is obtained. If the impression period of a driving pulse P0 becomes out of range [the aforementioned inequality], the orientation for the effect of fluctuation of the impression period of the driving pulse resulting from fluctuation of the scan speed of carriage to become easy to appear in the flight speed of an ink drop will come out.
[0051] Whether it uses independently or a means to set up the impression period of a means to set up the pulse width of a pulse P1 more greatly than AL, and a driving pulse P0 so that substantially equally to the integral multiple of AL uses both collectively, respectively, it is effective, and it can form a high-definition image.
[0052]
[Example] One half of the values of the acoustical resonant period of AL which is the characteristic value of a pressure generating room, i.e., a pressure generating room, impress the driving pulse which took the sufficiently long repeat period T by the above-mentioned drive wave to the piezoelectric device of an ink drop fuel injection equipment, and are calculated as pulse width from which the speed of an ink drop becomes max by measuring the speed of the ink drop when fixing the voltage value V of a square wave and changing the pulse width W1 of a square wave.
[0053] The characteristic value AL of the ink drop fuel injection equipment of example 1 this example was 8.8 microseconds from the measurement result shown in drawing 8 . That is, drop speed is most efficiently obtained to driver voltage by setting the pulse width W1 of a drive wave as this AL.
[0054] The repeat period T is set to 5AL(s) by the above-mentioned drive wave, the pulse width W1 of a square wave is changed to the ink drop fuel injection equipment H shown in drawing 3 , the driver voltage value V is raised in the drive wave of each pulse width, and the result of having measured the marginal drop speed in which outgoing radiation just before starting the contamination of the air bubbles from a nozzle is possible is shown in drawing 9 . Marginal drop speed was able to become max in 9.7 microseconds (1.1AL) which made pulse width W1 larger than AL, and was able to carry out outgoing radiation to stability in the range of AL<W1<1.3AL to a bigger drop speed than the case where W1 is set as AL.
[0055] The result of having measured the speed and drop volume of a drop to which AL which is the characteristic

value of an example 2 pressure generating room sets the pulse width W1 of the above-mentioned drive wave as 5.2 microseconds, fixes the driver voltage value V to 15V in the drop fuel injection equipment for 4.8 microseconds, changes the repeat outgoing radiation period T, and outgoing radiation is carried out is shown in drawing 10 . When an outgoing radiation period (equal to the impression period of a driving pulse P0) is changed, in order to make small fluctuation of the flight speed of an ink drop, and the volume of an ink drop and to maintain a stable outgoing radiation condition from this result, it turns out that it is desirable to set the central value of an outgoing radiation period as AL which is the maximum point or the minimum point of the inflection curve of drawing (n+1/3).
[0056] In the aforementioned example, the aforementioned conditions were able to be fulfilled by falling with build-up-time deltaT of a pulse P1 and a pulse P2, and constituting time amount deltaT from a square wave for 0.5 microseconds.

[0057]
[Effect of the Invention] It is high and invention of claim 1 enables it to realize flight speed of the stable ink drop and to form the image of high image quality at high speed.
[0058] It becomes possible by claims 2 and 3 or invention of 4 to make an ink drop fly especially at high speed, and it becomes possible to form a high-definition image in stability.
[0059] It becomes possible to maintain an outgoing radiation condition at stability, when making an ink drop fly at a high speed continuously especially, and to form a high-definition image in stability by claim 5 or invention of 6.
[0060] Invention of claim 7 enables it to control fluctuation of the ink drop gap by fluctuation of the scan speed of carriage etc., and it becomes possible to form a high-definition image.
[0061] It becomes possible for fluctuation of an ink drop gap to be controlled especially good by invention of claim 8, and to form a high-definition image by it.
[0062] It becomes possible to maintain an outgoing radiation condition at stability, when making an ink drop fly at a high speed continuously especially, and to form a high-definition image in stability by claim 9 or invention of 10.
[0063] Since a high speed and a high-definition shear mode ink drop fuel injection equipment are realized by invention of claim 11 and a driving pulse generating means can be constituted from a drive circuit of only a single polar power supply, layout of a circuit and manufacture are easy.
[0064] The efficient drive using acoustical resonance is attained by claim 12 or invention of 13, and reduction of the power consumption concerning a drive is attained.

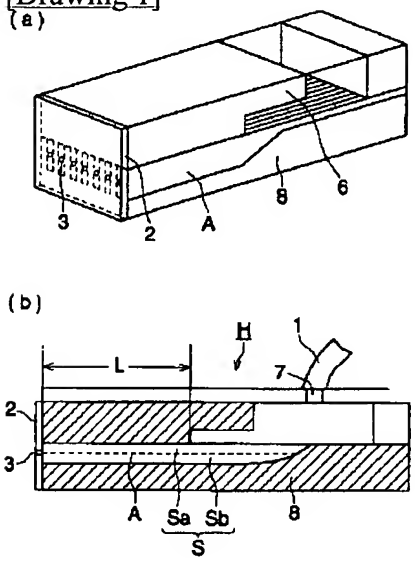
[Translation done.]

* NOTICES *

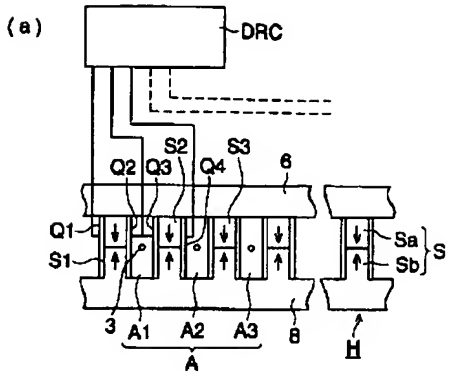
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

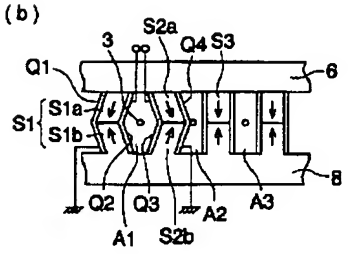
DRAWINGS

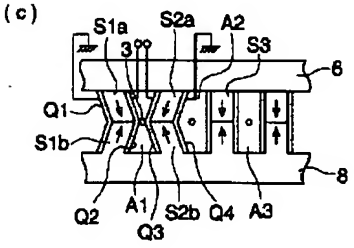
[Drawing 1]



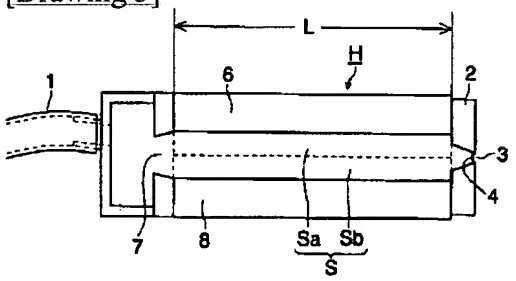
[Drawing 2]



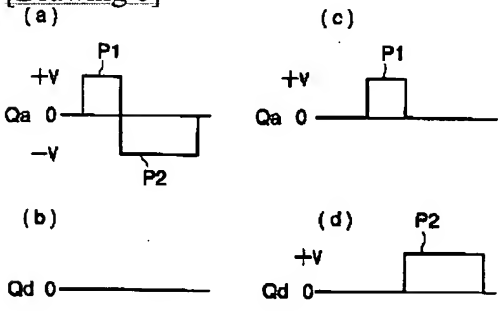




[Drawing 3]

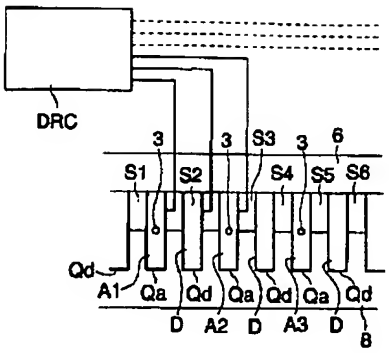


[Drawing 6]



[Drawing 4]

(a)



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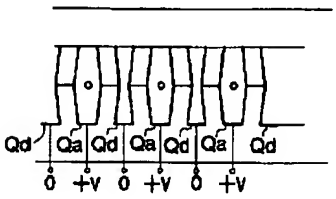
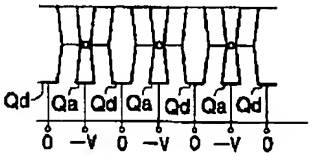


[Drawing 5]

(a)



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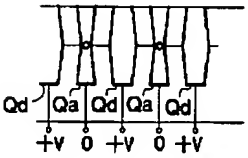
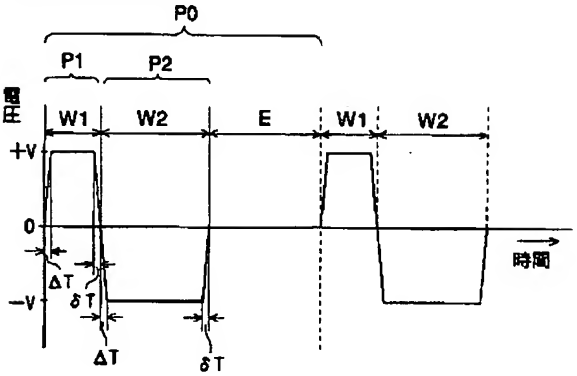
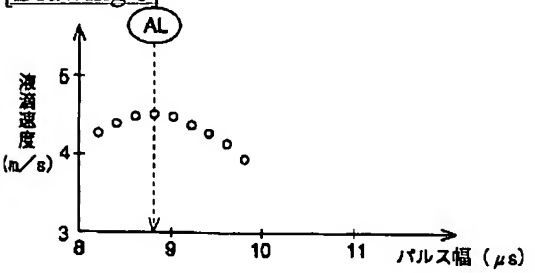


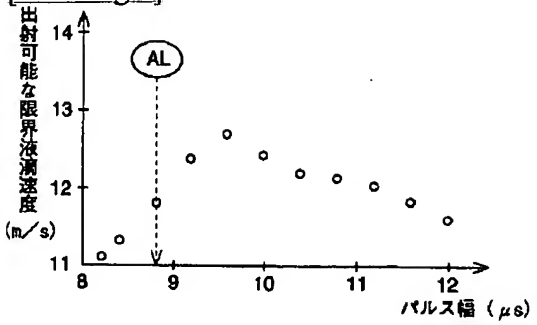
[Drawing 7]



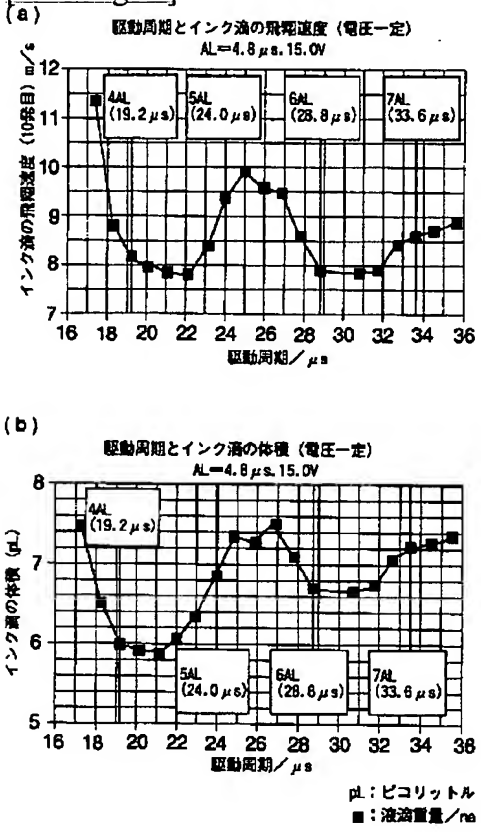
[Drawing 8]



[Drawing 9]



[Drawing 10]



[Translation done.]